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Modelling of PV Array with MPP Tracking & Boost DC-DC Converter

Mohammad Yasir[a], Faraz Khan[b], Farazuddin Siddiqui[c*]
[a]*Student M.tech (Power System), AIET, Lucknow (U.P.), India*
[b]*Lab Instructor (Electronic & Simulation Lab), Integral University, Polytechnic Campus Shahjahanpur (U.P.), India*
[c] *Lecturer (Electrical), Integral University, Polytechnic Campus Shahjahanpur (U.P.), India*

Abstract: *In any solar plant output of PV arrays varies due to change of solar irradiance and other conditions. Therefore, the maximum power point tracking algorithm is implemented in DC-DC converter to enable PV arrays to operate at maximum power point. This paper presents the averaged model for PV array with Maximum Power Point Tracking (MPPT) boost converter. This model consists of PV module and MPPT boost DC-DC converter. The incremental conductance algorithm is employed to control the boost converter. Instantaneous report of system stability & efficiency is stimulated under the normal variation of solar irradiance or in any condition through MATLAB simulation.*

Keywords: *Maximum Power Point Tracking (MPPT) Boost converter ; Solar cell model ; Solar cell connected with Grid & PV array averaged Model,; Switched-mode Boost DC-DC converter; Distributed Generation (DG), Incremental Conductance (IC) algorithm; Concentrating Solar Plant(CSP).*

I. Introduction

Photovoltaic (PV) researches of this age are focusing upon boosting solar cell conversion efficiencies, lowering the cost of solar cells, modules, and systems, and improving the reliability of PV systems as well as components. We effort to contribute these goals through Modelling of grid connected PV system. To achieve the goal of maximum efficiency, it is necessary to track this maximum power point (MPP) called as MPPT (Maximum Power Point Tracking). Here PV module, DC-DC converter and MPPT (P&O algorithm) are modelled using MATLAB Simulink.

Since the main focus is on tracking the MPP by adjusting the duty cycle of DC-DC converter.

Generally MPPT techniques are employed through two ways: (1) by hardware implementation and (2) by software modelling. Software modelling of equation model is used here by using block or subsystem to represent these system equations. We try best to control duty cycle & hence the output voltage of PV in modelling of DC-DC converter.

In general it is preferred to employ circuit model for modelling the DC-DC converter modelling but when we analyse this under circuit model we face several difficulties of it. Such as:

a) It is supported by the limited software;
b) It is difficult to modify the model;
c) It avoids for creating the new model.

So the main aim of the paper is the modelling of DC-DC converter using equation modelling to track the MPP of PV module/array, which allows the input voltage of the DC-DC converter to be controlled by MPPT algorithm.

II. Modelling of Components

a) Simple PV cell (ECEN2060)

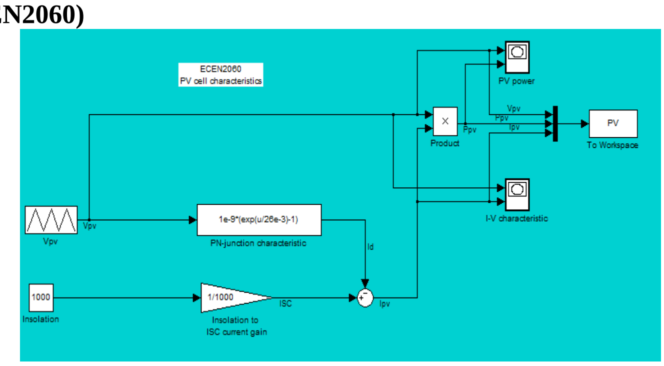

Figure 1: Simple PV cell Simulink model(Simulation stop time: t =1)

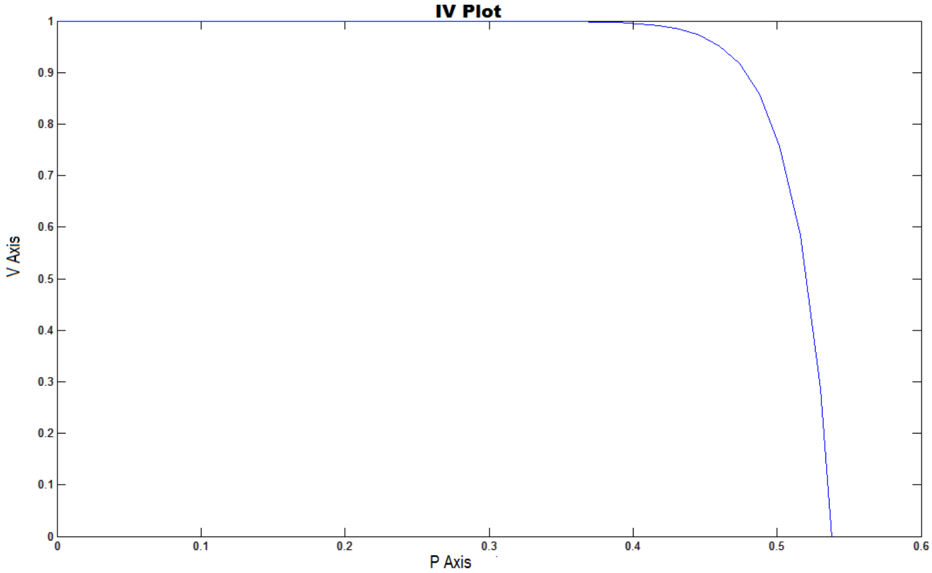

Figure 2: I-V Characteristics (Result of fig 1)

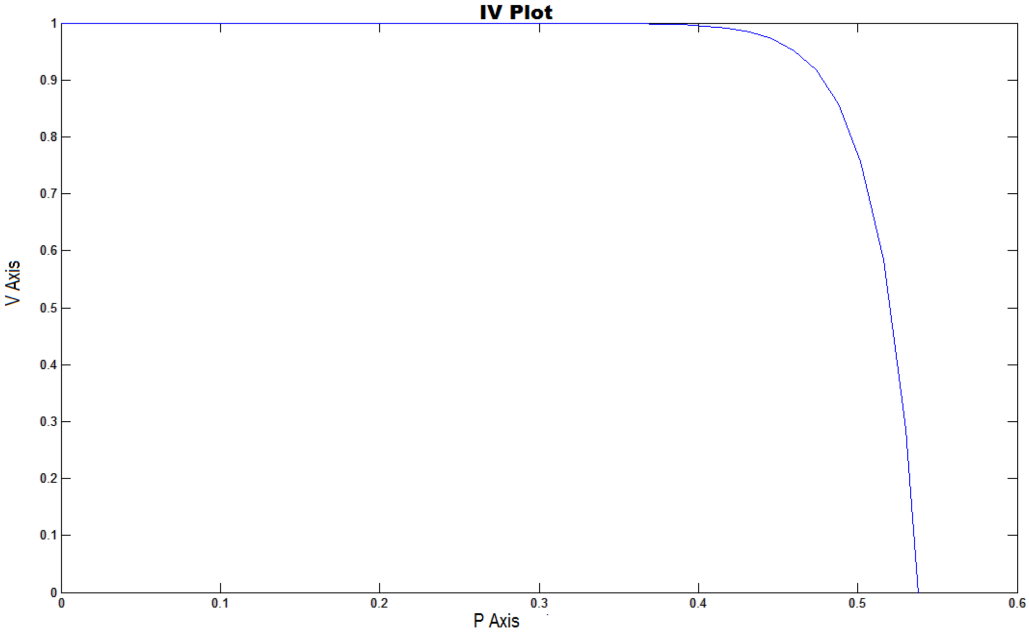

Figure 3: P-V Characteristics (Result of fig 1)

b) Dc-Dc Boost Converter

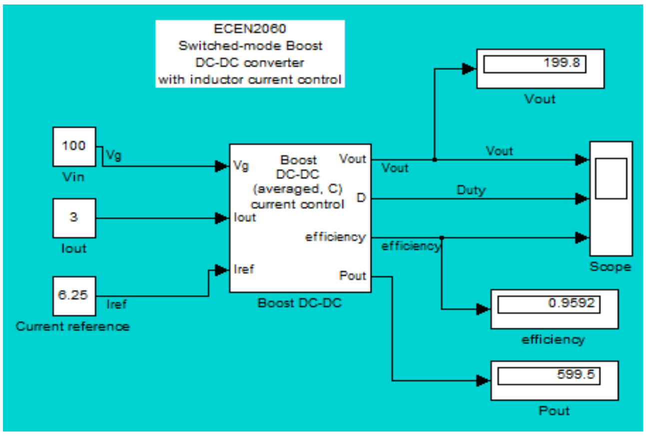

Figure 4: Switched Mode Boost DC-DC converter with inductor current control (averaged Model) t=2/60.

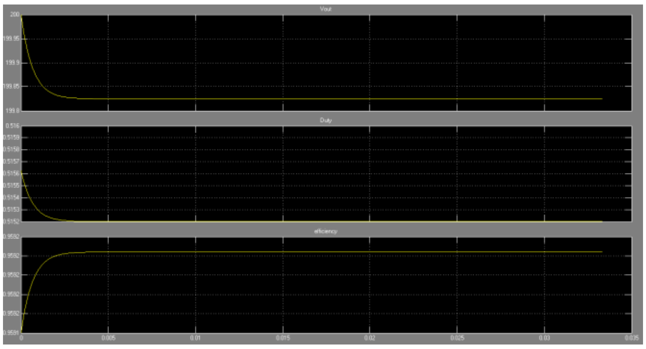

Figure 5: Result of fig 4 (Vout= 199.8, Efficiency=0.9592, Pout= 599.5)

C) Dc-Ac Inverter

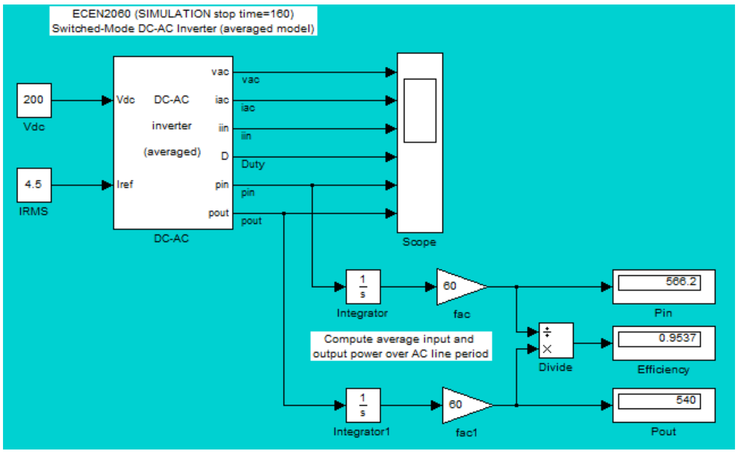

Figure 6: Switched-Mode DC-AC Inverter for grid connected system (averaged model) t=1/60

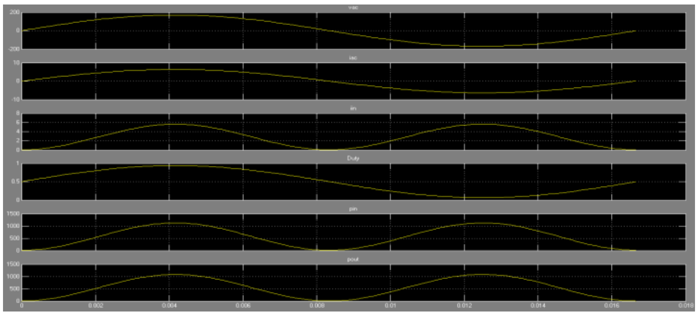

Figure 7: Result of fig 6 (Pin= 566.2 Efficiency=0.9537 Pout=540)

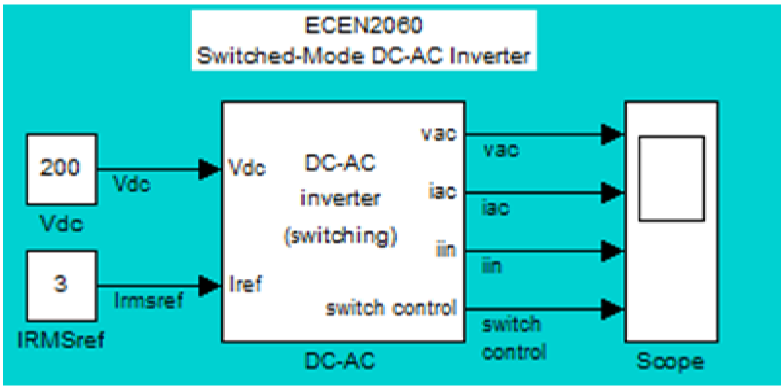

Figure 8: Switching-Mode DC-AC Inverter for grid connected system t=1/60

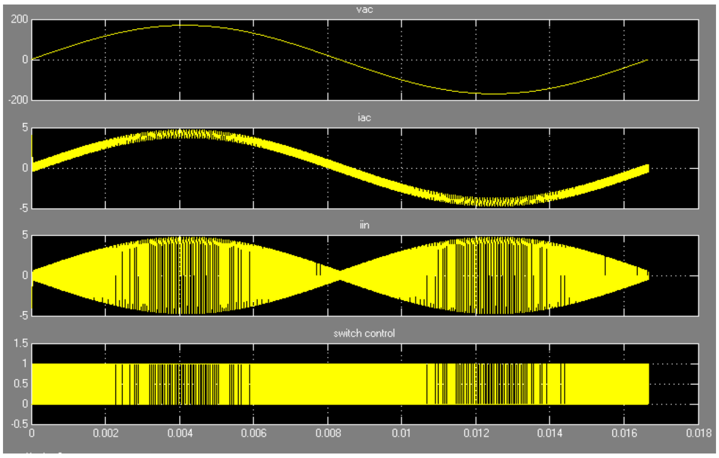

Figure 9: Result of fig 8

III. Modelling for PV array with MPPT DC-DC Boost converter

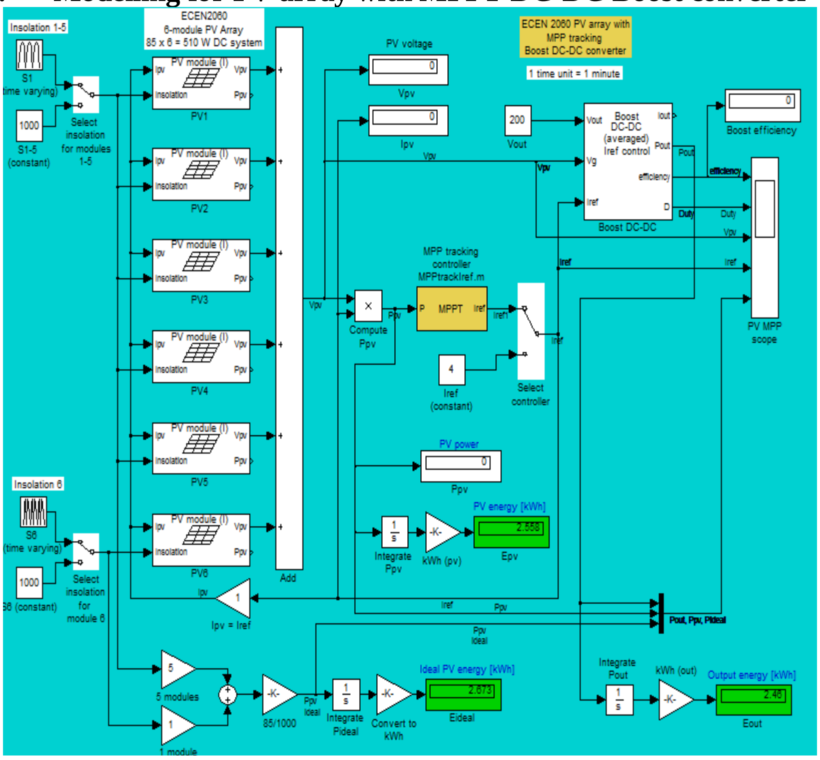

Figure 80: Averaged Model for PV array with MPP tracking Boost DC-DC converter t=60*8

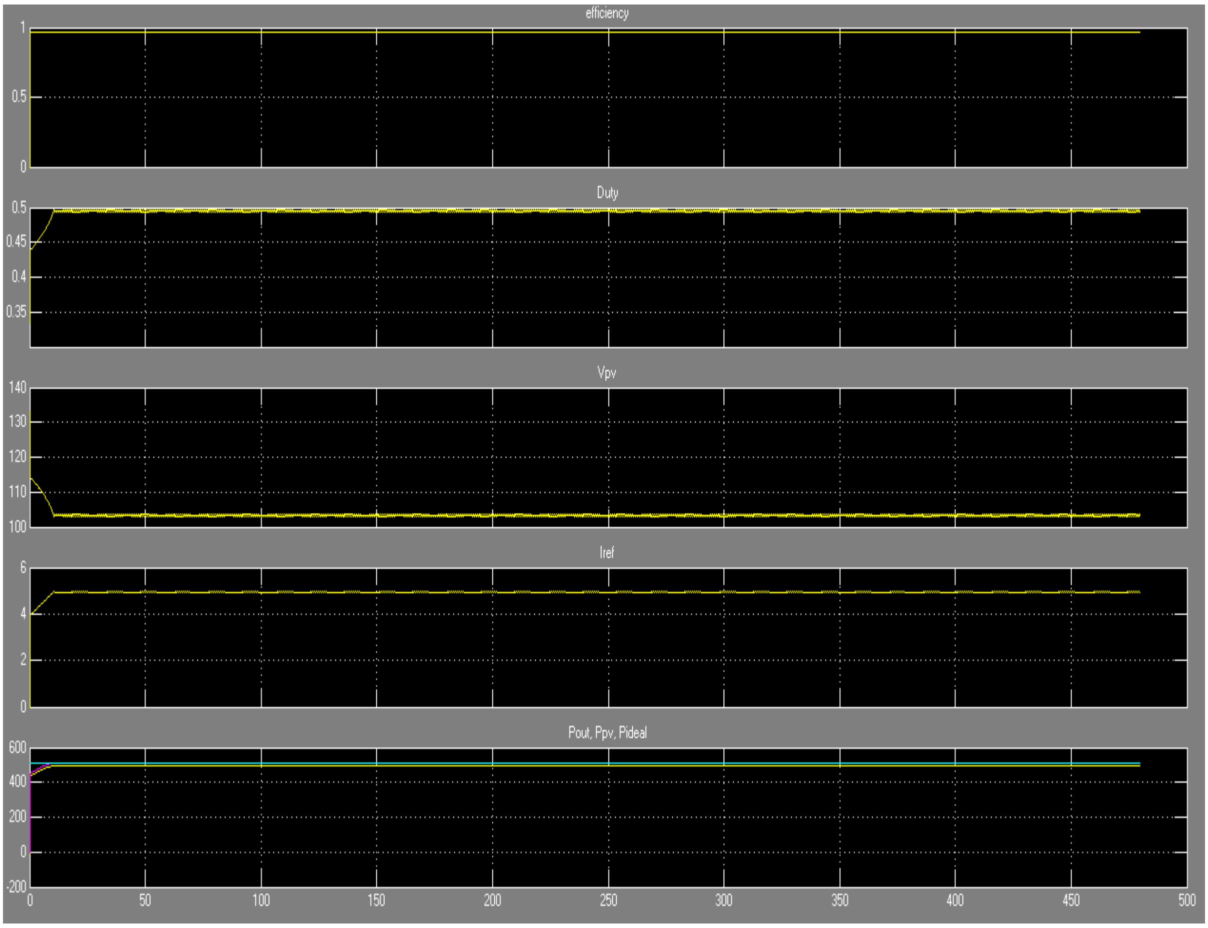

Figure 11: The experiment result of the model with MPPT control under constant weather

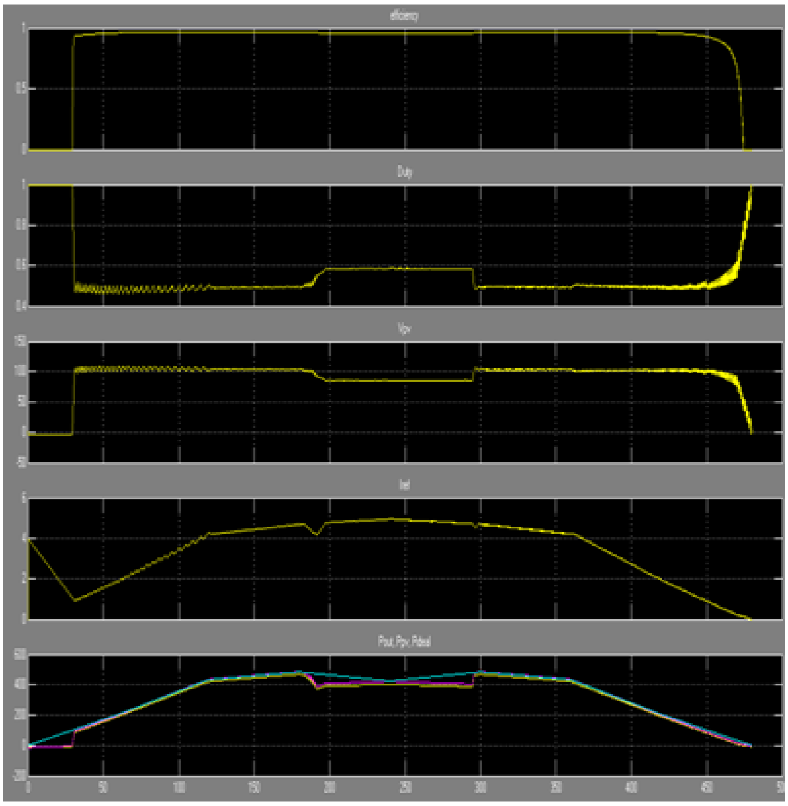

Figure 9: The experiment result of the model without MPPT control under constant weather

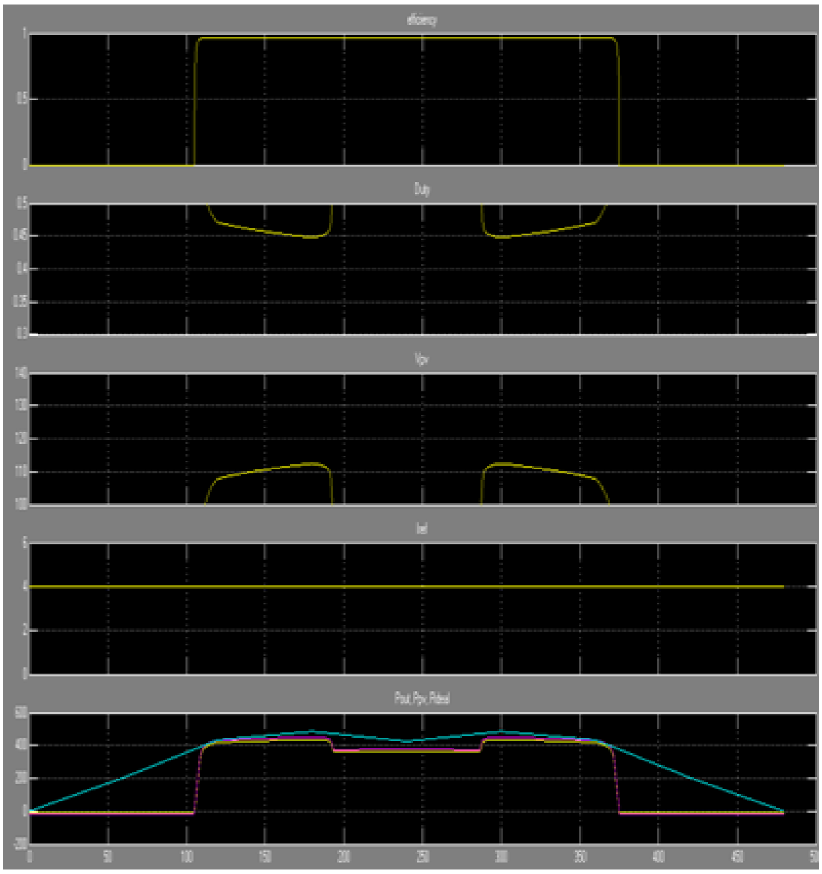

Figure 10: The experiment result of the model without MPPT control under time varying weather

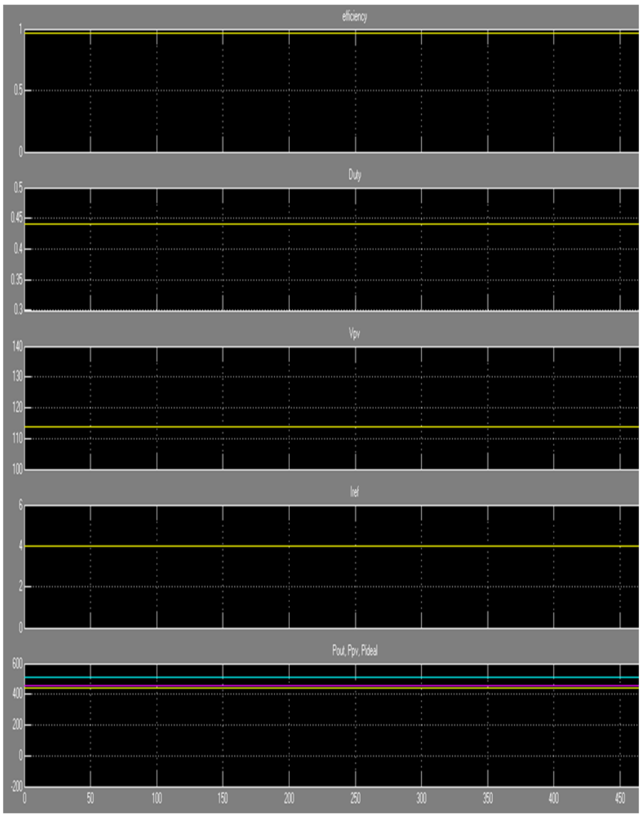

Figure 11: The experiment result of the model with MPPT control under time varying weather

IV. Simulation Result

SN.		pv voltage(Vpv)	PV current(Ipv)	Boost efficiency	PV power(Ppv)	PV Energy (Epv)	Ideal PV energy (Eideal)	output energy (Eout)
		(in Volt)	**(in Ampere)**	**(in %)**	**(in Watt)**	**(in kWh)**	**(in kWh)**	**(in kWh)**
Constant irradiance								
1	The experiment result of the model with MPPT control	103.4	4.94	96.44%	510.8	4.081	4.087	3.936
2	The experiment result of the model without MPPT control	113.4	4	96.92%	455.2	3.642	4.087	3.56
Under time varying irradiance								
3	The experiment result of the model with MPPT control	-	-	-	-	2.558	2.673	2.46
4	The experiment result of the model without MPPT control	-3.658	4	-	-14.63	1.788	2.673	1.755

Table 1: Simulation Results.

V. Conclusion

Through the presented modelling we open the new door for High-Performance PV Projects. Hence, this paper will be helpful for U.S. Department of Energy's Sun-Shot Initiative to make large-scale solar energy systems cost-competitive with the other sources of energy.

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